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39
ORIGINAL

FLOOD INSURANCE STUDY

CITY OF HACKENSACK, NEW JERSEY
BERGEN COUNTY

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Federal Emergency Management Agency

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PUBLISHED SEPARATELY:

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Flood Insurance Rate Map

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Hackensack, Bergen County, New Jersey, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert Hackensack to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these federally-supported studies are based. These criteria take precedence over the minimum federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3. In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by the New Jersey Department of Environmental Protection for the Federal Emergency Management Agency, under Contract No H-4546. This work was completed in November 1979. The hydrologic and hydraulic analyses for this study were performed by URS/MSR Engineers under sub-contract to the New Jersey Department of Environmental Protection.

1.3 Coordination

Streams requiring detailed study were identified at an initial consultation and Coordination Officer's (CCO) meeting attended by representatives of the FEMA, the City of Hackensack, and the state coordinating agency.

A search for basic data was made at all levels of government. In January 1978, a letter was submitted to the mayor and city engineer requesting any available stream data, topographic mapping, information related to

past flood problems, flood protection measures that have been implemented or are being planned within the city, and any other information which the city would like incorporated into the study.

An intermediate CCO meeting was held in April 1979 attended by representatives of the FEMA, the New Jersey Department of Environmental Protection (NJDEP - the study contractor), URS/MSR Engineers, and local officials. Preliminary delineations were reviewed and commented upon at this meeting.

On January 6, 1982, the results of this study were reviewed at the final CCO meeting attended by representatives of the FEMA, the study contractor, and the City of Hackensack.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Hackensack, Bergen County, New Jersey. The area of study is shown on the Vicinity Map (Figure 1).

Coles Brook was studied by detailed methods from its confluence with the Hackensack River to just above Grand Street. The Hackensack River was studied in detail for its entire length within the community. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction for the next five years, through November 1984.

The upstream portion of Coles Brook was studied by approximate methods. Approximate methods of analysis were used to study those areas having low development potential and minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the FEMA.

2.2 Community Description

The City of Hackensack is located in south-central Bergen County in northwestern New Jersey, approximately 6 miles from the George Washington Bridge. It is bordered on the north by the Boroughs of Paramus and River Edge, on the east by the Township of Teaneck, the Borough of Bogota and the Village of Ridgefield Park, on the south by the Borough of Little Ferry, the Township of South Hackensack and the Boroughs of Teterboro and Hasbrouck Heights, and on the west by the Boroughs of Lodi and Maywood. The Hackensack River forms a natural boundary on the east and Coles Brook forms a natural boundary on the west.

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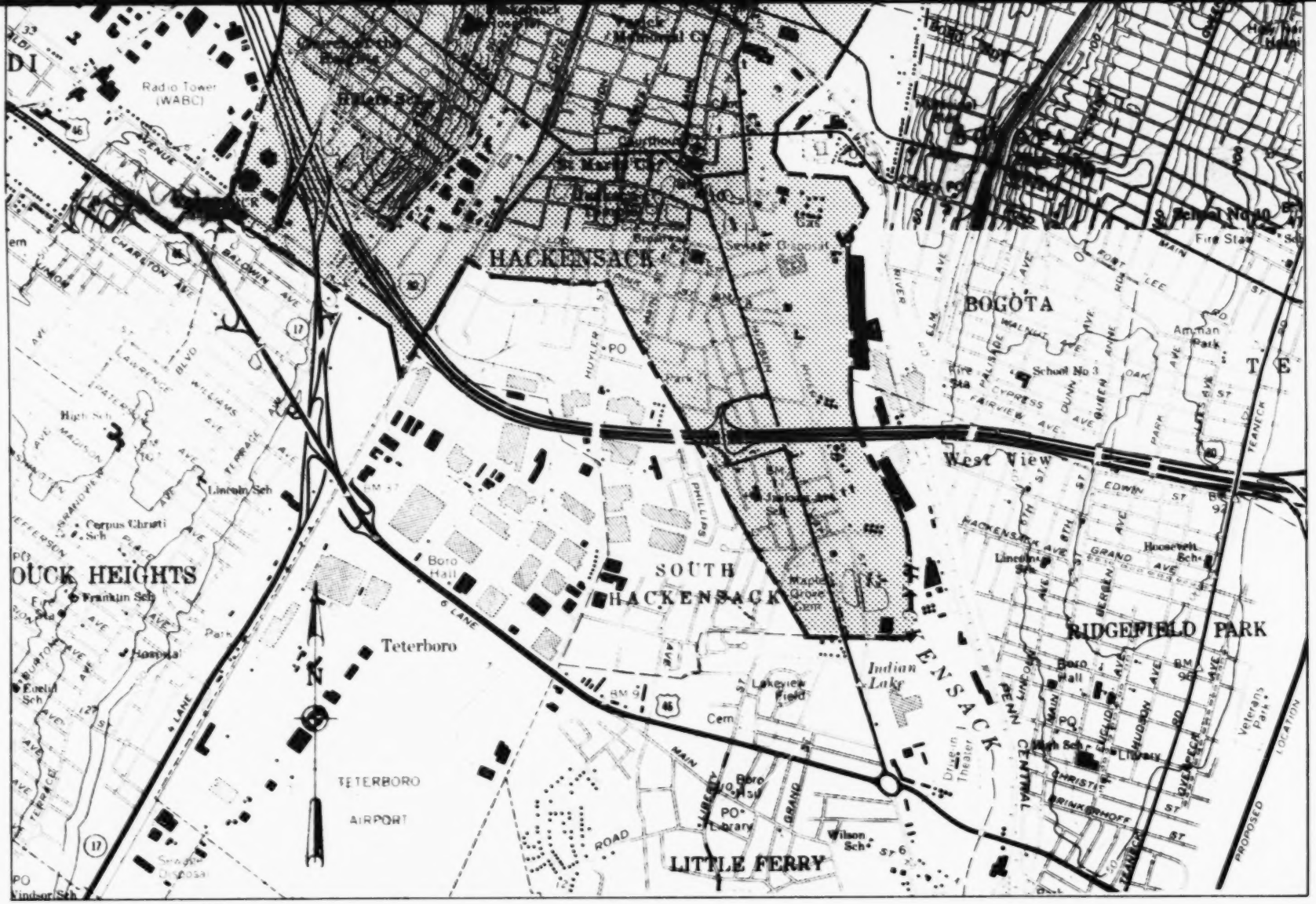

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HACKENSACK, N J

(BERGEN CO.)

APPROXIMATE SCALE

2000 0 2000 4000 6000 FEET

VICINITY MAP

The history of the City of Hackensack goes back to the 1660's when the Dutch and then the English began to move out from the Village of Bergen (Jersey City). In 1709, Hackensack became the county seat of Bergen County, and the commercial, professional, legal, and amusement center for the area. Hackensack grew as a business center, with two railroads and river borne cargo. Some industry, such as brickmaking, began in the area, but then as today, Hackensack was mainly a residential and commercial center. The present population is approximately 37,000 persons, and is fairly stable.

Hackensack is located in the midst of the huge highway system that traverses northeastern New Jersey. State Routes 4, 17, and 46, and Interstate Routes 80 and 95 (the New Jersey Turnpike), surround the city, allowing easy access from the entire tri-state area. Most local traffic is handled by Essex Street, Passaic Street, Summit Avenue, Main Street, and Hudson Street.

Elevations in the city range from sea level at the Hackensack River up to 80-110 feet at the ridge along Summit Avenue, to approximately 30 feet along Coles Brook. The ridge line basically divides the city into 2 drainage basins, although certain small parts in the southwest drain to Stink Creek in the Borough of Lodi, and the East Riser Ditch in the Borough of Moonachie.

For most of its length, Coles Brook is the corporate limits between Hackensack and the Boroughs of Maywood, Paramus, and River Edge. The stream lies in a well developed drainage basin, so storm runoff occurs rather quickly, causing flash flooding. Stink Creek (north) is also subject to flash floods because it too is in an area that is fully developed, with much residential encroachment on the channel. In addition, the basin is crossed by State Routes 17 and 46, and by Interstate Route 80, which complicated the drainage pattern by relocating the streams and ditches.

Although not fully developed, the lowlands adjacent to the Hackensack River contain residences, industrial plants, and educational facilities.

It is difficult to rate the soils within the city because most are in active urban use. The majority of cover is stratified drift consisting of sands, clay and gravel overlying Triassic sandstones and red shale. There is some active tidal marsh and some drained and filled areas.

Hackensack is part of the generally temperate climate zone common to the mid-Atlantic seaboard. Marked changes of weather are frequent, especially in the spring and fall. Winters are moderate with snowfall of about 32 inches, and summers are hot with occasional thunderstorms.

Average annual temperature is about 54 degrees Fahrenheit (°F), with yearly extremes between -10°F and 100°F. Annual precipitation is 44 inches, with August the wettest month and January the driest.

2.3 Principal Flood Problems

Most of the flooding in the City of Hackensack occurs along the Hackensack River from upstream of Interstate Route 80 to the confluence of Coles Brook. Along Coles Brook, major flooding occurs upstream of State Route 4. This flooding is in part confined to an area which is bounded by Conrail and Johnson Avenue, which is mostly an industrial area with some residential structures.

The Hackensack River is controlled by the 500 year tide almost to the confluence of Coles Brook in the City of Hackensack. Because of this tidal influence, the fluvial flows resulting from past storms are not the principal source of flooding. Local storm runoff when associated with high tide frequencies results in flooding due to interior drainage problems.

The Hackensack River watershed generally consists of flat overbanks with extensive natural storage provided by marsh and lowlands bordering the main stream. Flood flows, because of the nature of the overbanks and upstream reservoirs, have only a moderate effect.

The storm of record for this stream occurred on September 27, 1975. The U. S. Geological Survey (USGS) gage located at New Milford, New Jersey, recorded a flow of 4,300 cubic feet per second (cfs), with an associated gage height of 7.54 feet (Reference 1). This flow is equal to a flow with an approximate recurrence interval of 25 years.

The 100-year fluvial flow on the Hackensack River bordering the City of Hackensack ranges from 7,510 cfs to 7,410 cfs, and produces a water-surface elevation ranging from 5 to 7 feet. The 100-year tide elevation of approximately 6 feet controls the water-surface profile for the majority of the river which borders the city.

2.4 Flood Protection Measures

The Hackensack Avenue bridge, which crosses Coles Brook, is currently being replaced by the Engineering Division of the Department of Public Works, Bergen County, New Jersey. The City of Hackensack has not indicated that any other major flood protection measures are planned.

The Hackensack Meadowlands Development Commission, authorized by state statute in January 1969, has jurisdiction over development in the Hackensack Meadowlands. In connection with the New York District of the

U. S. Army Corps of Engineers (COE), flood protection measures for the Hackensack River are being studied. Various plans for flood control have been presented by the COE in their draft report on the Hackensack River basin and their Environmental Impact Statement to construct a tidal barrier and dredge the Hackensack River (References 2 and 3).

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one-percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten) and, for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

The tidal analyses for this study were performed by Tippetts-Abbett-McCarthy-Stratton (TAMS) under subcontract to the NJDEP. The coastal engineering and hydraulic studies made for this report were based on previous studies made by TAMS since the mid 1960's. Because of the different conditions of areas located at and inland from the mouth of the Hackensack River, the present studies were divided into two parts: the frequency analysis of tides at Upper Newark Bay and the frequency analysis and flood level delineation in the Hackensack Meadowlands.

These studies were primarily aimed at determining the 100- and 500-year flood elevations in the areas of interest. For this, frequency distributions for high tides at the Battery, New York, and East Newark, New Jersey, were obtained. In addition, studies made in connection with another contract between the COE and TAMS were used to obtain the 10-year flood elevations inside the Meadowlands.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency and peak elevation-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

The hydrology for Coles Brook was developed using statistical analyses and parameters, according to the methods described in Magnitude and Frequency of Floods in New Jersey with Effects of Urbanization (Reference 4). This report is based on a regression analysis of 103 gages in the State of New Jersey and is used to estimate peak-flood magnitudes having selected recurrence intervals for drainage basins larger than 1.0 square mile with various degrees of urban or suburban development. Parameters used in this method are basin size, channel slope, surface storage, and population density.

Fluvial flows for the Hackensack River were proportioned to drainage areas using an appropriate transfer coefficient between the values developed for the Flood Insurance Study for the Boroughs of Ridgefield and New Milford, New Jersey (References 5 and 6). The flows used in the New Milford study were modified after determining that the existing values were within the confidence limits of the log-Pearson Type III flood flow frequency analysis as developed by the USGS (Reference 7).

A summary of drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges".

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
COLES BROOK					
At the confluence with the Hackensack River	7.3	1,020	1,585	1,900	2,745
HACKENSACK RIVER					
Upstream of the confluence of Overpeck Creek	134.4	3,455	5,625	7,510	9,390
Upstream of Interstate Route 80	132.1	3,410	5,555	7,410	9,260

It was subsequently determined that the tidal elevations along the Hackensack River submerge all fluvial elevations computed for Coles Brook up to Kinderkamack Avenue and for all of the Hackensack River along the City of Hackensack.

A report presented to the FEMA in January 1980, entitled "Frequency Distribution for Hurricane and Northeaster Tides at the Battery and Upper Newark Bay", describes the methods used for this portion of the study and the resulting frequency distribution (Reference 8). The following paragraphs are a summary of its pertinent chapters.

Tide Analysis at the Battery, New York:

The recorded tide is the result of the astronomic (or predicted) tide and the meteorologic component, usually referred to as the surge. This component is produced by wind shear on the ocean surface of the continental shelf off New York Bay, and by the local atmospheric pressure drop produced by the storm. The influence of the astronomic tide on the magnitude of the surge is assumed negligible, and the two components are considered statistically independent events. Consequently, the occurrence of any combination of magnitudes of the two components is considered a random event.

A disaggregation program was written to separate the two components for a given recorded tide, using the known astronomic tide sequence. This results in the determination of the surge ordinates.

The astronomic tide may be obtained from the Tide Tables or from a computation using the harmonic tide equation (Reference 9). However, this tide is referenced to mean sea level, which has long-term and seasonal variations. Therefore, a correction must be included to reference the astronomic tide to the National Geodetic Vertical Datum of 1929 (NGVD). The sea level in the vicinity of New York has been rising during this century at the rate of about 1.2 feet per century, so it now is approximately 0.6 foot above its 1929 level, which was used to define NGVD. However, yearly variations in mean sea level may vary considerably from the long-term trend and therefore, when disaggregating the tide for a given storm event, attention was paid to the recorded sea level for the year of occurrence.

Seasonal sea level variations are superimposed on long-term variations. In the New York area the median predicted high tide for January is 0.66 foot below the median high tide for September. Seasonal mean sea level variations are incorporated in the equations used to compute the astronomic tide, so there is no correction to be made in this regard for the present disaggregation study. The analysis was prefaced by an inspection of histories of significant storms as recorded by the National Weather Service and the COE. A total of 563 northeaster events were analyzed for the period between 1926 and 1976. In addition, a total of 22 hurricane events were similarly analyzed for the period between 1963 and 1976. The storms were selected according to their track positions as probable

candidates for surge production. These storm analyses were added to those made for hurricanes occurring in the period starting in 1926, as presented by Wilson, Harris, and Pore and Barrientos (References 10, 11 and 12).

Separate frequency distributions for northeaster and hurricane surge peaks were obtained by ranking the surge peaks obtained from the disaggregation studies.

To describe the development of the surges, standard sequences of surge heights were used. These expressed the history of the heights in terms of the surge peak. The duration of each sequence was assumed equal to 48 hours for northeasters and 17 hours for hurricanes.

The northeaster surge sequence was developed by TAMS for this study after a study of the largest recorded surges, corresponding to the 1950 and 1953 northeasters, obtained by the New York District of the COE.

The hurricane surge sequence was obtained from previous studies by Wilson and has been used extensively by TAMS for studies conducted for the COE (References 10 and 13).

The assumption that each type of storm would have a standard surge sequence permitted the determination of surge heights during the development of the storm tide in proportion to the surge peak. Consequently, the surge peak frequency was considered applicable to the sequence as a whole.

The storm tide is the sum of the surge heights and the astronomic tide. Since these are statistically independent events, the probability of occurrence of any combination of astronomic tide and surge must be obtained by joint frequency analysis.

The astronomic tide was represented by a sine-curve with a period of 12.4 hours (semi-diurnal); its elevations, with respect to prevailing mean sea level, were considered dependent on the tidal range (spring to neap) and time during the tidal cycle. These are the two most relevant variables characterizing the astronomic tide. Consequently, the frequency of occurrence of a storm tide elevation was obtained from the product of the frequencies of the peak surge, the tidal range and the time during the tidal cycle.

An aggregation program was written to perform the computations. In addition to establishing the ordinates of the surge corresponding to a surge peak of given frequency, using the standard surge sequence, this program added these ordinates to those of the sinusoidal tide and established the maximum tide elevation. The program also obtained the exceedence probabilities of each maximum storm tide elevation.

These computations were made separately for hurricane and northeaster surges. The resulting frequency curves were combined by adding the frequencies obtained with each kind of storm for given storm tide elevations, as these are independent series of events. It was found that the contribution of hurricane-storm tides to the tide frequency distribution was considerably less important than that of the northeasters.

Tides at East Newark:

To obtain tide elevation frequencies at East Newark, a correlation was established between high waters there and at the Battery, using the results from Wilson's study and also TAMS linear regression analysis (References 10 and 13). This correlation allowed transposition of storm tide frequencies from the Battery to East Newark.

Finally, since the above computations resulted in estimated tides with respect to prevailing mean sea level, these were corrected by adding 0.6 foot to obtain elevations of equal frequency with respect to NGVD, for storm tides obtained using present (1980) mean sea level.

Frequency distribution curves for the Battery and East Newark were obtained through the above analyses. The storm tide elevations at the Battery and East Newark are shown in Table 2, "Storm Tide Elevations".

TABLE 2 - STORM TIDE ELEVATIONS

	1980 ESTIMATE (feet NGVD)	
RETURN PERIOD	THE BATTERY	EAST NEWARK
10	7.0	7.4
100	9.5	10.0
500	10.5	11.0

A summary of peak elevation-frequency relationships for Coles Brook and the Hackensack River is shown in Table 3, "Summary of Elevations".

TABLE 3 - SUMMARY OF ELEVATIONS

	ELEVATION (feet)			
FLOODING SOURCE AND LOCATION	10-YEAR	50-YEAR	100-YEAR	500-YEAR
COLES BROOK				
At the confluence with the Hackensack River	6.9	8.3	8.9	9.4

TABLE 3 - SUMMARY OF ELEVATIONS - continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
HACKENSACK RIVER				
At the downstream corporate limits	6.8	8.2	8.9	9.3
At the upstream corporate limits	6.9	8.3	8.9	9.4

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

Channel cross sections and partial overbank cross sections were obtained through field surveys. The overbanks were extended using topographic maps compiled from aerial photographs at a scale of 1:2,400 with a contour interval of 5 feet (Reference 14).

In areas where aerial photographs did not indicate most recent developments, full cross sections of the stream were taken. All bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Channel roughness factors (Manning's "n") used in the hydraulic computations were assigned based on field inspection of various cross sections in the flood plain areas. For Coles Brook, the main channel roughness values ranged from 0.025 to 0.035 and the overbank values ranged from 0.070 to 0.090. The roughness values for the main channel of the Hackensack River ranged from 0.025 to 0.035 and the overbank values ranged from 0.040 to 0.090.

Water-surface profiles for the streams studied by detailed methods were developed using the COE HEC-2 step-backwater computer program (Reference 15). Starting water-surface elevations for Coles Brook were determined by the slope/area method. Starting water-surface elevations for the Hackensack River were taken from a rating curve developed by the COE. Cross sections were located at close intervals upstream and downstream of bridges and culverts in order to compute the significant backwater effects of those structures.

The hydraulic analyses to obtain the tidal elevations in the Meadowlands were made using the LATIS mathematical model developed by TAMS in connection with previous studies for the COE, using a development configuration corresponding to 1981 plans by the Hackensack Meadowlands Development Commission (HMDC) (Reference 13). This represents the degree of encroachment occurred in the tidal swampland and its connecting streams.

Program LATIS has been developed by TAMS for the finite difference integration of the dynamic and continuity equations of gradually varied unsteady flow in a network of channels and reservoirs. The Meadowlands were divided into a series of nodes, with arbitrary boundaries which established the boundaries of such reservoirs. The reservoir areas within the node boundaries were planimetered taking into consideration natural or fill ground elevations. Such areas were input as tables of areas versus elevations for each node.

The links were defined as reaches of streams in the Meadowlands connecting the nodes. These were considered open channels with hydraulic characteristics input as tables in terms of water surface elevations at the nodes adjacent to each link. The model boundary conditions were defined by the tide at Node 1, located at the mouth of the Hackensack River in Upper Newark Bay, and 25 inflow links where fluvial inflow hydrographs were defined according to information provided by the New York District of the COE.

The boundary conditions for runs made according to the present contract consisted of tides of a given frequency at Node 1 in conjunction with the 1-year fluvial hydrographs for all the inflow links. This combination was ascribed a frequency of occurrence equal to that assumed for the tide considering, as stated above, that the two events were independent.

Experience with the model demonstrated that flooding in the study area is predominantly tidal, and elevations resulting from a given tide are not sensitive to fluvial flows, with the exception of the Teterboro airport area. Therefore, the error in the assumption of complete independence of floods and tides is negligible.

The model was operated alternatively using hurricane and northeaster tides at Node 1. The frequency of a given tide elevation inland is equal to the sum of the frequencies of obtaining such an elevation from a hurricane or a northeaster storm tide at the mouth. Therefore, to obtain the 100- or 500-year elevations at each of the nodes of the model, storm tides of lesser frequencies at the mouth should be used for routing.

The routings were made using hurricane and northeaster tides of 100 and 200 years of return period. The resulting elevations at each of the nodes were plotted on log paper versus the individual frequencies of the

tides at the mouth, from which two frequency distribution straight lines were drawn for each node. It was immediately found that hurricane frequency does not have a noticeable influence beyond Penhorn Creek.

The combined frequency curves could be obtained by addition of frequencies for each elevation at each node. The 100- and 500-year elevations resulted from interpolation with the resulting graphs for such periods.

In addition, 10-year northeaster and hurricane tides were routed through the model in connection with another contract with the COE and from these runs the 10-year and 50-year elevations were obtained. These runs also resulted in the estimates for the 50-, 100- and 500-year floods in the Teterboro area.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 3).

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929. Locations of the elevation reference marks used in the study are shown on the maps.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FEMA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. The 100- and 500-year boundaries were delineated using topographic maps compiled from aerial photographs of the study area at a scale of 1:2,400, with a contour interval of 5 feet (Reference 14). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year boundary has been shown.

The approximate flood boundaries shown for the upper reaches of Coles Brook were taken directly from the Flood Hazard Boundary Map for the City of Hackensack (Reference 16).

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 3). Small areas within the flood boundaries may lie above the flood elevations and, therefore, may not be subject to flooding. Owing to limitations of the map scale and lack of detailed topographic data, such areas are not shown.

Flood boundaries are also indicated on the Flood Insurance Rate Map. On this map, the 100-year flood boundary corresponds to the boundary of the areas of special flood hazards (Zone A4), and the 500-year boundary corresponds to the boundary of areas of moderate flood hazards (Zone B).

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood can be carried without substantial increases in flood heights. Minimum standards of the FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. However, the State of New Jersey has established criteria limiting the increase in flood heights to 0.2 foot. Thus, floodways having no more than a 0.2-foot surcharge have been delineated for this study. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plains. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 4). Portions of the floodway widths for Coles Brook and the Hackensack River extend beyond the corporate limits.

As shown on the Flood Boundary and Floodway Map (Exhibit 3), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the flood-

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH[3] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Coles Brook								
A	65[1]	86/35	419	4.5	8.9	4.8[4]	5.0	0.2
B	730[1]	76/45	494	3.8	8.9	5.5[4]	5.6	0.1
C	1,335[1]	42/25	245	7.8	8.9	5.6[4]	5.7	0.1
D	1,720[1]	140/25	474	4.0	8.9	7.1[4]	7.2	0.1
E	2,120[1]	80/25	399	4.8	8.9	7.8[4]	7.9	0.1
F	2,470[1]	58/28	333	5.7	8.9	8.4[4]	8.5	0.1
G	2,790[1]	39/28	263	7.2	10.4	10.4	10.4	0.0
H	2,970[1]	92/18	361	5.3	11.0	11.0	11.2	0.2
I	3,220[1]	116/65	524	3.6	12.2	12.2	12.3	0.1
J	3,850[1]	66/50	426	4.5	13.8	13.8	13.9	0.1
K	4,020[1]	78/50	361	5.3	14.7	14.7	14.8	0.1
Hackensack River								
A	96,900[2]	577/325	3,589	2.1	8.9	6.7[4]	6.9	0.2
B	97,470[2]	571/500	3,300	2.2	8.9	6.7[4]	6.9	0.2
C	98,300[2]	276/165	2,054	3.6	8.9	6.9[4]	7.1	0.2
D	99,600[2]	344/130	2,438	3.0	8.9	7.3[4]	7.5	0.2

[1]Feet above confluence with Hackensack River
[2]Feet above confluence with Newark Bay
[3]Width/width within corporate limits
[4]Elevation computed without consideration of backwater effects from Newark Bay

TABLE 4

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HACKENSACK, NJ
(BERGEN CO.)

FLOODWAY DATA

COLES BROOK AND HACKENSACK RIVER

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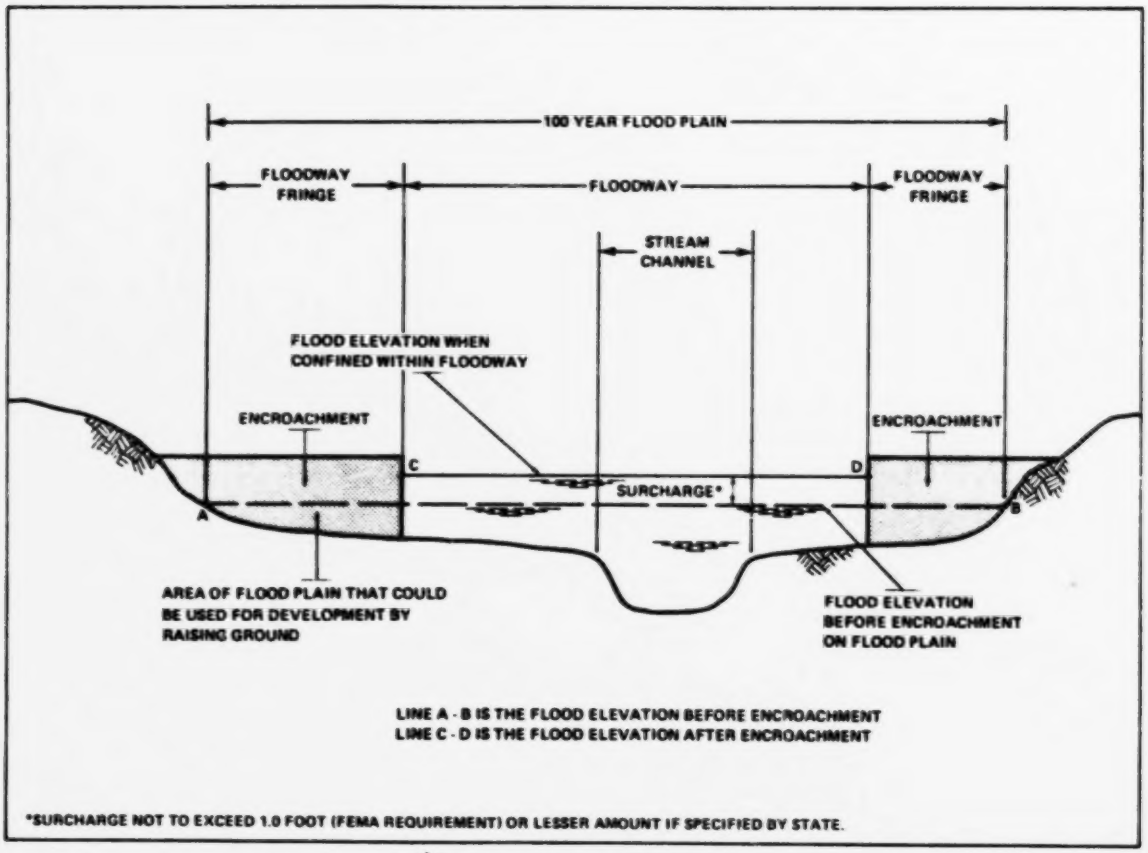
way and the 100-year flood are either close together or collinear, only the floodway boundary has been shown. Floodways were determined for Coles Brook and the Hackensack River although they are influenced partially or totally by tidal flooding rather than by fluvial flow.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 0.2 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC Figure 2

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "With Floodway" elevations presented in Table 4 for certain

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downstream cross sections of Coles Brook and the Hackensack River are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to tidal flooding from other sources.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source affecting the City of Hackensack.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the portion of Coles Brook affected by fluvial flow in the City of Hackensack are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 5).

In tidal areas, reaches are limited to the distance for which the difference between the 10- and 100-year flood elevations does not vary more than 1.0 foot. Using these criteria, the downstream portion of Coles Brook and the Hackensack River shoreline qualifies as one reach whose flooding source is Newark Bay. The location of this reach is shown on the Flood Insurance Rate Map.

5.2 Flood Hazard Factors

The FHF is the FEMA device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Coles Brook							
Reach 1	01	-3.1	-0.7	+1.6	030	A6	Varies
Reach 2	01	-2.4	-0.5	+1.3	025	A5	Varies
Newark Bay (Tidal flooding affecting Coles Brook and the Hackensack River)	01,02	-2.0	-0.6	+0.5	020	A4	9

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HACKENSACK, NJ
(BERGEN CO.)

FLOOD INSURANCE ZONE DATA

COLES BROOK AND NEWARK BAY

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the City of Hackensack was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A4, A5, and A6:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHF.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also, areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 5, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the City of Hackensack.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Hackensack is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation

lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FEMA.

6.0 OTHER STUDIES

Flood Insurance Studies for the Boroughs of Ridgefield and Maywood have been published (References 5 and 17). Flood Insurance Studies for the adjacent Boroughs of Bogota, Little Ferry, Paramus, River Edge, the Village of Ridgefield Park and the Township of Teaneck are currently being prepared (References 18, 19, 20, 21, 22, and 23). All of these studies will be in exact agreement with this study for the City of Hackensack.

This study is authoritative for purposes of the Flood Insurance Program, and the data presented here either supersede or are compatible with previous determinatiors.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Insurance and Mitigation Division of the Federal Emergency Management Agency, Regional Director, Region II Office, 26 Federal Plaza, Room 19-100, New York, New York 10278.

8.0 BIBLIOGRAPHY AND REFERENCES

1. U. S. Department of the Interior, Geological Survey, Water Resources Data for New Jersey, Part 1, Surface Water Records, Washington, D. C., Published Annually, 1922 to the Present.

2. U. S. Army Corps of Engineers, New York District, Hackensack River Basin Report (Unpublished).

3. U. S. Army Corps of Engineers, New York District, Environmental Impact Statement, Permit to Construct a Tidal Barrier and Dredge in the Hackensack River, Bergen County, New Jersey, September 1977 (Unpublished).

4. State of New Jersey, Department of Environmental Protection, Division of Water Resources, in cooperation with the U. S. Geological Survey, Special Report 38, Magnitude and Frequency of Floods in New Jersey with Effects of Urbanization by Stephen J. Stankowski, Trenton, New Jersey, 1974.

5. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Ridgefield, Bergen County, New Jersey, Washington, D. C., March 15, 1977.

6. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of New Milford, Bergen County, New Jersey, Washington, D. C., October 1, 1976.

7. U. S. Department of the Interior, Geological Survey, Log-Pearson Type III Flood Flow Frequency Analysis, Trenton, New Jersey, August 1978.

8. Tippetts-Abbett-McCarthy-Stratton Engineers, "Frequency Distribution for Hurricane and Northeaster Tides at the Battery and Upper Newark Bay", New York, New York, January 1980.

9. U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Tide Tables, High and Low Water Predictions for the Atlantic Coast of North and South America, Washington, D. C., 1980.

10. U. S. Army Corps of Engineers, Beach Erosion Board, Office of the Chief of Engineers, Technical Manual 120, The Prediction of Hurricane-Storm Tides in New York Bay by B. W. Wilson, New York, New York, 1960.

11. U. S. Department of Commerce, Weather Bureau, Characteristics of the Hurricane Storm Surge by D. L. Harris, Washington, D. C., 1963.

12. Marine Ecosystems Analysis Program, New York Bight Project, New York Sea Grant Institute, Storm Surge by N. A. Pore and C. S. Barrientos, Albany, New York, 1976.

13. Tippetts-Abbett-McCarthy-Stratton Engineers, Hackensack Meadowlands Mathematical Study, Report to the U. S. Army Corps of Engineers, New York District, New York, New York, March 1975.

14. Geod Aerial Mapping Inc., of Oak Ridge, New Jersey, Topographic Maps compiled from aerial photographs, Scale 1:2,400, Contour Interval 5 Feet: City of Hackensack, New Jersey, 1978.

15. U. S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Generalized Computer Program, Davis, California, October 1973.

16. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, City of Hackensack, Bergen County, New Jersey, Washington, D. C., October 2, 1974, Revised October 31, 1975.

17. U. S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, Borough of Maywood, Bergen County, New Jersey, Washington, D. C., February 15, 1977.

18. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Borough of Bogota, Bergen County, New Jersey (Unpublished).

19. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Borough of Little Ferry, Bergen County, New Jersey (Unpublished).

20. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Borough of Paramus, Bergen County, New Jersey (Unpublished).

21. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Borough of River Edge, Bergen County, New Jersey (Unpublished).

22. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Village of Ridgefield Park, Bergen County, New Jersey (Unpublished).

23. Federal Emergency Management Agency, Federal Insurance Administration, Flood Insurance Study, Township of Teaneck, Bergen County, New Jersey (Unpublished).

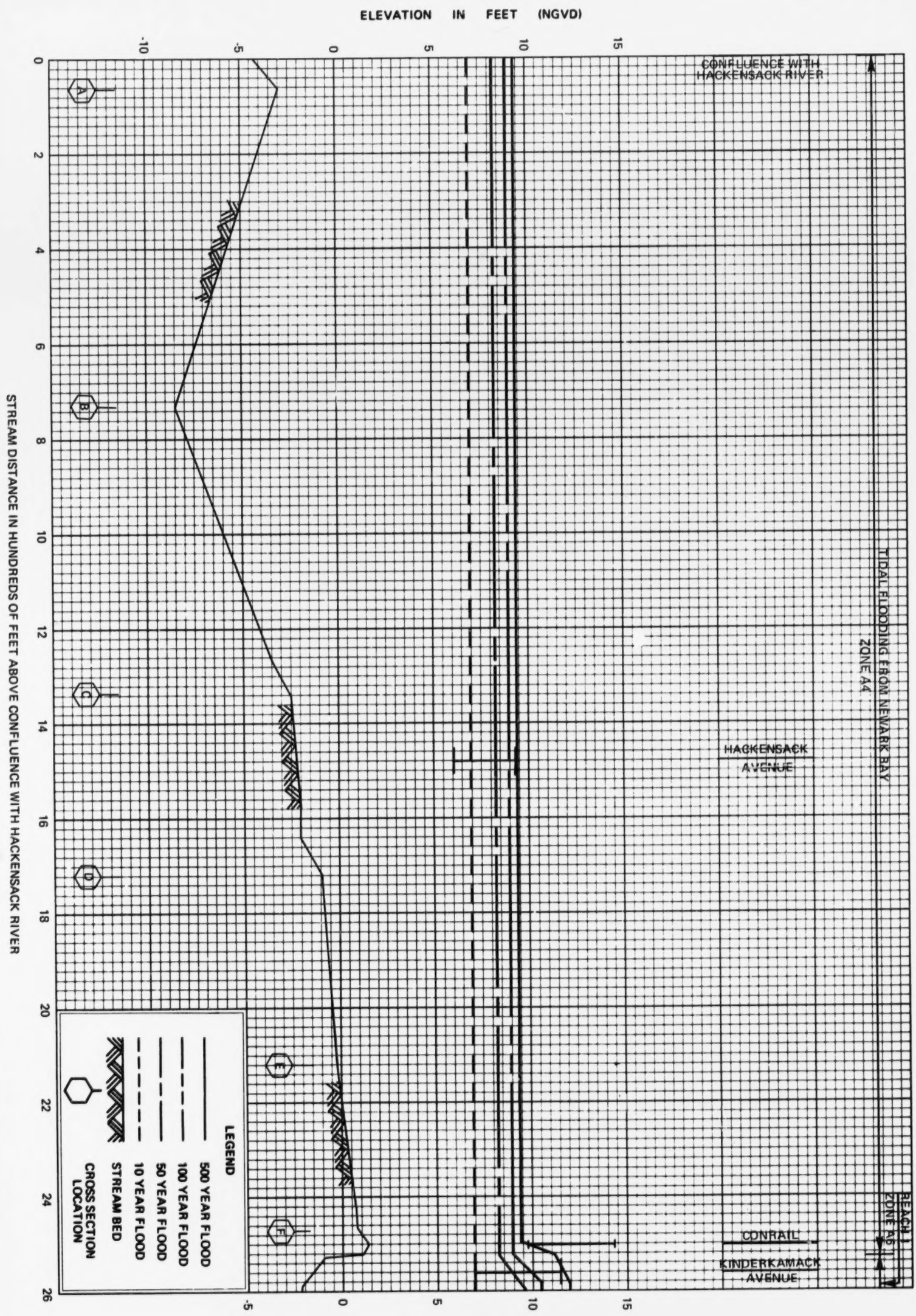
Manganaro, Martin and Lincole, Bergen County, New Jersey, Southwest Area Drainage Study, New York, New York, August 1970.

Proceedings of the American Society of Civil Engineers, Professional Paper No. 3046, Hurricane Studies of New York Harbor By S. Goyseyeff and F. L. Panuzio, February 1962.

Seelye, Stevenson and Value, Overpeck Tidal Dam Report for Bergen County, New York, New York, February 8, 1953.

U. S. Department of Commerce, Bureau of Public Roads, Hydraulic Design Series No. 3, Design Charts for Open-Channel Flow, Washington, D. C., August 1961.

U. S. Department of the Interior, Geological Survey, Water Supply Paper No. 1849, Roughness Characteristics of Natural Channels by Harry H. Barnes, Jr., Washington D. C., 1967.



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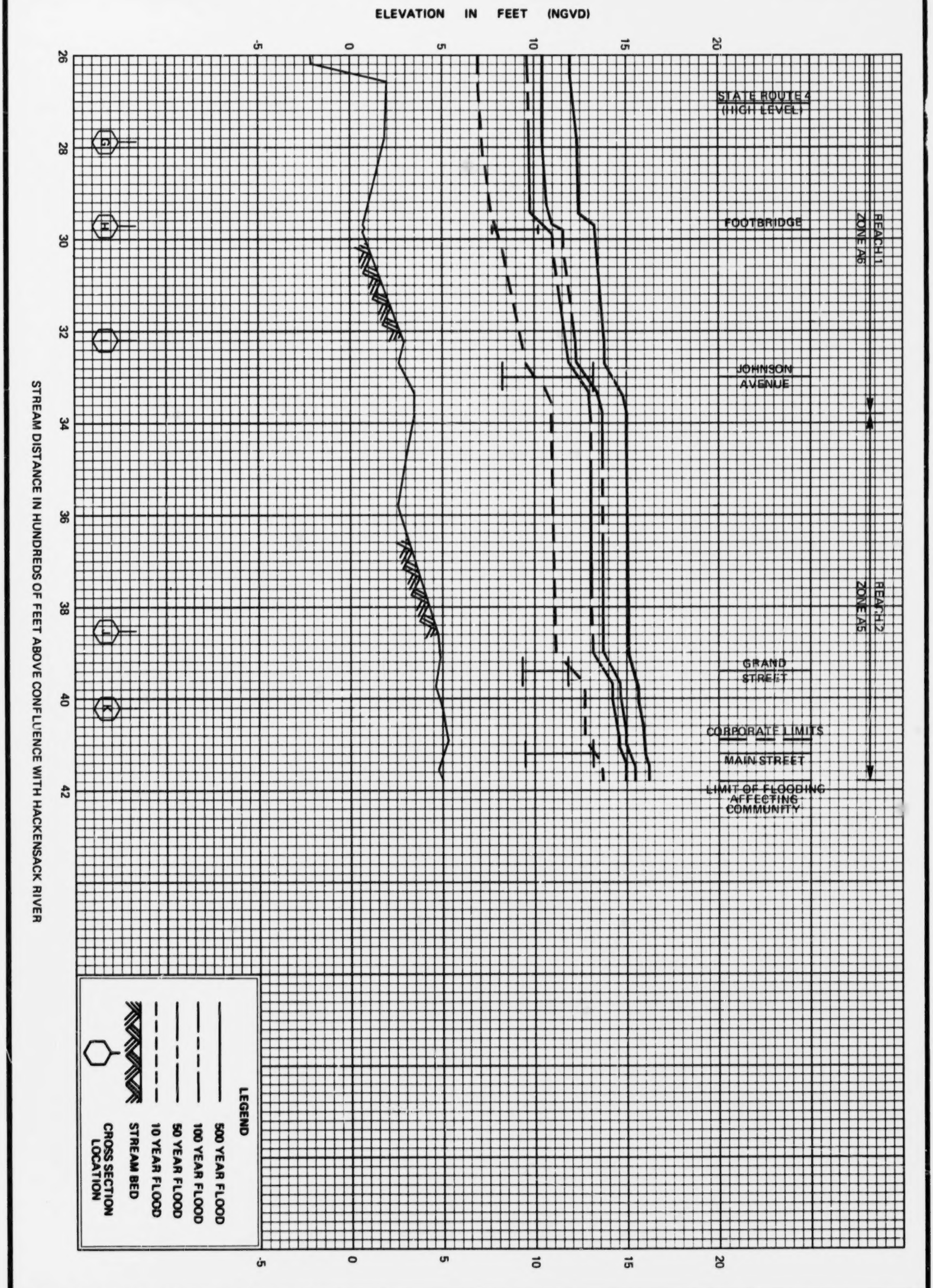

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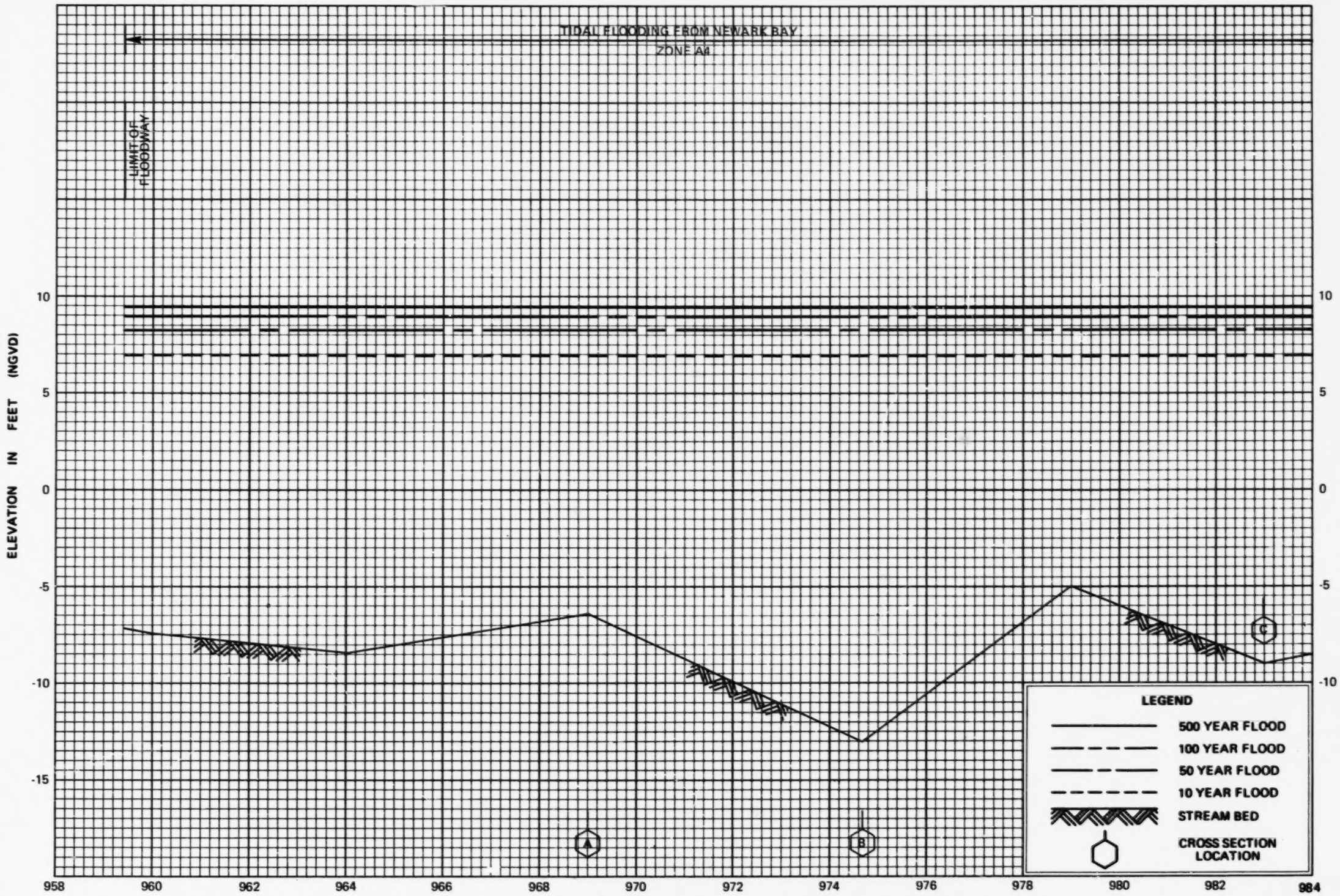
FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HACKENSACK, NJ
(BERGEN CO.)

FLOOD PROFILES

COLES BROOK



FLOOD PROFILES

HACKENSACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HACKENSACK, NJ
(BERGEN CO.)

03P

TIDAL FLOODING FROM NEWARK BAY
ZONE A4

CORPORATE LIMITS

CONFLUENCE OF COLES BROOK

ELEVATION IN FEET (NGVD)

10
5
0
-5
-10

984 986 988 990 992 994 996 998

STREAM DISTANCE IN HUNDREDS OF FEET ABOVE CONFLUENCE WITH NEWARK BAY

LEGEND

- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- STREAM BED
- CROSS SECTION LOCATION

FLOOD PROFILES

HACKENSACK RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF HACKENSACK, NJ
(BERGEN CO.)

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